

# Dimerous Electron and Quantum Interference beyond the Probability Amplitude Paradigm

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**Abstract.** We generalize the formerly proposed relationship between a special complex geometry (originating from the structure of biquaternion algebra) and induced real geometry of (extended) space-time. The primordial dynamics in complex space allows for a new realization of the “one electron Universe” of Wheeler-Feynman (the so called “ensemble of duplicons”) and leads to a radical concept of “dimerous” (consisting of two identical matter pre-elements, “duplicons”) electron. Using this concept, together with an additional phase-like invariant (arising from the complex pre-geometry), we manage to give a visual classical explanation for quantum interference phenomena and, in particular, for the canonical two-slit experiment. Fundamental relativistic condition of quantum interference generalizing the de Broglie relationship is obtained, and an experimentally verifiable distinction in predictions of quantum theory and presented algebrodynamical scheme is established.

## 1 Introduction. Algebrodynamics in the primordial complex space

In our recent papers [1, 2, 3] we have been elaborating the concept that primordial physical dynamics takes, in fact, place in the *complexified space-time*  $\mathbb{C}^3$ , an invariant subspace of the vector space of *biquaternion algebra*  $\mathbb{B}$ . It was assumed that structure of the latter entirely encodes both the geometry of physical space-time and the dynamics of physical fields and particles. Corresponding approach originating from the monograph [4]<sup>1</sup>, as well as from the ideas of W. Hamilton, C. Lanczos, D. Hestenes et al., has been called the *algebrodynamics*.

As to the *real* physical geometry, it is determined by the *modulus part*  $s^2$  of the principal complex invariant  $\sigma$  of the *automorphism group*  $SO(3, \mathbb{C})$  of  $\mathbb{B}$  algebra

$$\sigma := \mathbf{z} \cdot \mathbf{z}, \quad \mathbf{z} \in \mathbb{C}^3 \quad (1.1)$$

which, though non-negatively definite, can be equivalently represented in a remarkable Minkowski-like form [2, 6]:

$$s^2 := \sigma \sigma^* = (\mathbf{z})^2 (\mathbf{z}^*)^2 \equiv (\mathbf{z} \cdot \mathbf{z}^*)^2 - |\imath \mathbf{z} \times \mathbf{z}^*|^2 = t^2 - \mathbf{r}^2 \geq 0, \quad (1.2)$$

with

$$t := \mathbf{z} \cdot \mathbf{z}^*, \quad \mathbf{r} := \imath \mathbf{z} \times \mathbf{z}^* \quad (1.3)$$

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<sup>1</sup>References to the older works on algebrodynamics can be found therein, to the later ones – in the review [5]

being effective time-like and space-like coordinates of the induced real geometry, respectively. Under the  $SO(3, \mathbb{C})$ -automorphisms quantities  $t$  and  $\mathbf{r}$  transform in a Lorentz-like way (see the details in [2]). Thus, the (macro)geometry invariantly induced by the structure of biquaternions actually corresponds to the *causal part of the Minkowski space*  $\mathbf{M}$ , with invariant  $s^2$  in the role of a (necessarily non-negative) Minkowski interval.

Moreover, the compact *phase part* of complex invariant  $\sigma$  gives rise to an  $SO(3, \mathbb{C})$ -invariant geometrical phase  $\alpha$  “attached” to any point of the effective space  $\mathbf{M}$ . This phase turns out to be responsible for geometric explanation of wave properties of matter [3], see also below.

As to physical fields, these originate as the analogue of complex analytical functions generalized to the case of  $\mathbb{B}$  algebra. Because of non-commutativity of  $\mathbb{B}$ , resultant generalization of the *Cauchy-Riemann analyticity conditions* turns out to be *nonlinear* and represents itself the equations of unique fundamental field, the *biquaternionic field*, which is thus *self-interacting* and possesses, moreover, a natural *twistor (2-spinor) structure*. Gauge (complex Maxwell and  $SL(2, \mathbb{C})$  Yang-Mills) fields also find their place in the scheme. For exposition of non-commutative analysis (over quaternion-like algebras) and associated physical fields we refer the reader to the review [5].

Finally, in the framework of algebrodynamics, particles can be naturally identified with various types of singularities of corresponding “ $\mathbb{B}$ -meromorphic” functions-fields. Due to the presence of twistor structure, such a function gives rise to a light-like geometrical structure, namely, to a *shear-free congruence of rectilinear null rays*, both in the primordial complex and in the induced real space-time [7]. Within such a picture, particles (extended or point-like) correspond to *caustics*, *cusps* or *focal lines* of the above congruence [1]. Condition for caustic locus etc. plays the role of equation of particles’ motion and, at the same time, determines an instantaneous distribution of particle-like formations in space.

In this way, general physical picture arising in the framework of algebrodynamics seems to be self-consistent and closed. It follows only from the internal properties of biquaternions and  $\mathbb{B}$  analytical functions so that none additional canonical structures (e.g. Lagrangian, “external” symmetry group, quantization rules etc.) are introduced “by hands” in the scheme.

The goal of the below presented paper is to elaborate further the principal features of algebraic kinematics (dynamics) of particles-singularities in the primordial complex  $\mathbb{B}$  space and its “image” as it looks like in the associated real space-time  $\mathbf{M}$ . In particular, in Sec.2 we specify (generalize) the above described relationship between the primordial complex  $\mathbb{B}$  geometry and the invariantly associated Minkowski-like real space-time. In Sec.3, we briefly review the most interesting and intriguing features of algebrodynamics in the primordial  $\mathbb{B}$  space, in particular, the concepts of *duplicons* and of *dimerous “electrons”* formerly introduced in [1] and [3], respectively. In Sec.4, we make use of these concepts for alternative, purely classical explanation of the *quantum interference phenomenon* preliminarily presented in [3]. Sec.5 contains some final remarks on perspectives and status of the algebrodynamical theory.

## 2 Symmetries of biquaternion algebra and the induced real space-time

Apart from invariant (1.1), there is also the zeroth component  $z^0$  of a biquaternion  $Z$  which is also invariant under the  $SO(3, \mathbb{C})$  automorphisms of  $\mathbb{B}$  and should, generically, contribute

to the effective real geometry. As to physical motivations and consequences of the subsequent generalization of the induced geometry, they will become clear afterwards.

Specifically, in the canonical matrix representation of an element  $Z \in \mathbb{B}$  of the biquaternion algebra

$$Z = \begin{pmatrix} u & w \\ p & v \end{pmatrix} = \begin{pmatrix} z^0 + z^3 & z^1 - \imath z^2 \\ z^1 + \imath z^2 & z^0 - z^3 \end{pmatrix} \quad (2.1)$$

where  $\{u, w, p, v\} \in \mathbb{C}$ ,  $\{z^0, z^a\} \in \mathbb{C}$ ,  $a = 1, 2, 3$ , principal complex invariant  $\Sigma \in \mathbb{C}$  corresponds to the *determinant*

$$\Sigma := \det Z = (z^0)^2 - \mathbf{z}^2 \quad (2.2)$$

whose modulus part  $S^2 := \Sigma \Sigma^*$  is responsible for the real “macrogeometry” related to the full structure of vector space of  $\mathbb{B}$ . Making use of the evident identity (generalizing (1.2)):

$$S^2 = (\det Z)(\det Z)^* = \det Z Z^+ \equiv \det X, \quad (2.3)$$

one arrives again at the Minkowski-like geometry with effective space-time coordinates  $T, \mathbf{R}$  forming, as usual, the structure of a *Hermitean* matrix  $X := Z Z^+$ :

$$X \equiv X^+ = Z Z^+ = T + \mathbf{R} \cdot \sigma = \begin{pmatrix} T + X^3 & X^1 - \imath X^2 \\ X^1 + \imath X^2 & T - X^3 \end{pmatrix}, \quad (2.4)$$

$\sigma := \{\sigma_a\}$  being three *Pauli matrices*. In the procedure, real time-like  $T$  and space-like  $\mathbf{R} = \{X^1, X^2, X^3\}$  coordinates are expressed through the primary complex coordinates  $z^0, \mathbf{z}$  as follows:

$$T = |z^0|^2 + \mathbf{z} \cdot \mathbf{z}^*, \quad \mathbf{R} = z^0 \mathbf{z}^* + (z^0)^* \mathbf{z} + \imath \mathbf{z} \times \mathbf{z}^*, \quad (2.5)$$

whereas the principal (and *non-negative (!)*) Minkowski interval (2.3) completely reproduces its old form (1.2):

$$S^2 = \det X = T^2 - \mathbf{R}^2 \geq 0. \quad (2.6)$$

It is noteworthy to distinguish between symmetries of the formerly induced geometry and the generalized one defined through the mapping (2.5). Under the  $SO(3, \mathbb{C})$  rotations (precisely, under the transformations of the covering group  $SL(2, \mathbb{C})$ )

$$Z \mapsto A Z A^{-1}, \quad A \in SL(2, \mathbb{C}) \quad (2.7)$$

the space-time coordinates  $X$  do not, generically, transform through themselves. When only the transformation matrix  $A$  is *unitary*,  $AA^+ = id$ , one has a proper law for  $X$ , namely,  $X \mapsto A X A^+$  which in the considered case (2.1) corresponds to usual  $SO(3)$  rotations of a 3-vector  $\mathbf{R}$ . As to *boosts*, they have a special status in the scheme and can be accomplished (together with transformations of the whole proper *Lorentz group*) via *left shifts* in the  $\mathbb{B}$ -space,

$$Z \mapsto A Z \Rightarrow X \mapsto A X A^+ \quad (2.8)$$

which certainly are *not* automorphisms of  $\mathbb{B}$ . One can equivalently make use of the *right invariant* coordinate frame introduced by the conjugate mapping

$$Z \mapsto Z^+ Z. \quad (2.9)$$

To conclude, we have presented a pair of bilinear mappings  $Z \mapsto Z \times Z$  any of which naturally defines effective coordinates of the *causal part* of the Minkowski-like space  $\mathbb{M}$ . Indeed, under left (right) shifts of a  $\mathbb{B}$  matrix these coordinates undergo Lorentz transformations. However, under an arbitrary  $\mathbb{B}$  automorphism, they do not, generically, preserve their structure and should be defined anew after a  $\mathbb{B}$ -symmetry transformation. Nonetheless, the principal Minkowski interval (2.6) is evidently invariant under *any*  $\mathbb{B}$  automorphism (2.7).

For further needs, let us mention here (the details can be found in [3]) the assumption on *random (complex) time* (that is, on random alteration of the evolution  $\mathbb{C}$  valued parameter) and on the resulting random alteration of the effective coordinates  $X$  of all of the material objects. This conjecture makes it possible to identify the increments of effective coordinates  $\delta X = dZdZ^+$  with their differences  $\Delta X = (Z+dZ)(Z+dZ)^+ - ZZ^+$ , by virtue of cancellation of the “interference term”. As a result, at a “macroscopic” scale one is allowed to regard the *bilinear and thus non-holonomic* real space-time coordinates  $X$  as *effectively holonomic* and their increments thus as (effectively) *full differentials*. It is especially remarkable that this very hypothesis, in account of positive definiteness of the effective time coordinate (2.5), could resolve the eternal problem of *time irreversibility*. Indeed, any sequence of *random(!)* changes of the primary complex coordinates  $Z$  necessarily results in an *increase* of the physical time parameter  $T$  “in average”,  $\overline{\Delta T} \geq 0$ . This means also that one should distinguish between the two time scales, the microscopic  $T_{mic}$  and averaged macroscopic  $T_{mac}$  ones, which are related, as it usually takes place in random processes, as  $T_{mac} \sim \sqrt{T_{mic}}$ .

We now pass to a brief review of *kinematics* of particle-like formations in the primordial complex and induced real spaces.

### 3 Complex null cone, duplicons and the concept of dimerous electron

Fundamental physical dynamics takes place in the primordial complex  $\mathbb{B}$  space and originates from the solutions of the Cauchy-Riemann-like equations generalized to the noncommutative  $\mathbb{B}$  algebra. Corresponding “ $\mathbb{B}$ -differentiable” functions are considered as distributions of fundamental physical field (closely related to twistor or 2-spinor types of fields) while, geometrically, these give rise to congruences of (complex or induced real) shear-free rectilinear null rays [7]. Singularities (caustics) can be identified with particles and indicate their spatial distribution and temporal dynamics.

Remarkably, as we are going to demonstrate below, complex kinematics is nontrivial even for a single (complex) “world line” of a point-like particle-singularity  $\widehat{Z}(\tau)$ ,  $\tau \in \mathbb{C}$  corresponding to the *focal line* of the corresponding congruence of complex “null rays”. Specifically, let us write down the equation of (local) *complex null cone* (CNC) of a “moving” point singularity:

$$D := \det[Z - \widehat{Z}(\tau)] \equiv [z^0 - \widehat{z}^0(\tau)]^2 - [\mathbf{z} - \widehat{\mathbf{z}}(\tau)]^2 = 0, \quad (3.1)$$

$Z$  being an arbitrary fixed point of the  $\mathbb{B}$  space. CNC equation (3.1) is, in fact, the compatibility condition for a set of linear equations

$$[Z - \widehat{Z}(\tau)]\xi = 0 \Leftrightarrow \eta := Z\xi = \widehat{Z}(\tau)\xi \quad (3.2)$$

which introduces a principal 2-spinor  $\xi \in \mathbb{C}^2$  and a projective twistor  $\mathbf{W} = \{\xi, \eta\}$ ,  $\eta \in \mathbb{C}^2$  fields of the congruence. By virtue of the *incidence relations*, see the r.h.p. of (3.2), values of twistor field  $\mathbf{W}$  are preserved along any rectilinear element of CNC (3.1) connecting the point of (instantaneous) particle's location  $\widehat{Z}(\tau)$  and the point of “observation”  $Z$  which two are thus mutually “correlated”.

Importantly, on the corresponding real space-time  $X = X^+ \in \mathbf{M}$  induced through the above constructed mapping  $Z \mapsto X = ZZ^+$  fundamental equation of CNC (3.1) gives rise to equation of the local Minkowski *light cone*

$$DD^* = \det \left( [Z - \widehat{Z}(\tau)][Z - \widehat{Z}(\tau)]^+ \right) \equiv \det[X - \widehat{X}(\tau)] = (T - \widehat{T})^2 - (\mathbf{R} - \widehat{\mathbf{R}})^2 = 0, \quad (3.3)$$

or, equivalently, to the familiar *retardation equation*<sup>2</sup>. It is noteworthy to remark here that such a direct correspondence between CNC and real light cone in the induced  $\mathbf{M}$  space does not take place in the formerly introduced [2, 3] and described in Sec.1 geometry within which arbitrary value of the velocity of “propagation of interaction” ( $v \leq c$ ) is allowed. On the contrary, in the above presented version this is always universal and equal to the speed of light.

Let us now return to consideration of fundamental equation of CNC (3.1). Contrary to the real case, for a given point  $Z \in \mathbb{C}^4$  it can have a great (countable) number of solutions  $\tau = \tau_N(Z)$  any of which fixes a location  $\widehat{Z}(\tau_N)$  of the point particle in question at one and the same its “world line”. All these are correlated with the “observation point”  $Z \Rightarrow X = ZZ^+$  in complex as well as in real space along the elements of corresponding null cones, that is, are in a “light-cone interaction”. In [1], an analogous set of copies of point particle-like formations locating at a single complex “world-line” and (instantaneously) contributing through a “light cone field” (i.e., twistor, spinor field etc.) at a fixed space-time point  $X = ZZ^+$ , has been called the ensemble of *duplicons*. Concept of duplicons explains by itself the observed identity of the primary elements of matter reviving thus the old idea of Wheeler-Feynman [8] about *all of the electrons as one and the same particle observed in different positions at a single (entangled) world line*.

However, situation arising in the formalism of  $\mathbb{B}$  algebrodynamics turns out to be much more peculiar. In contrast to the permanently existing correlation (via the light cone) between  $Z$  and any of the duplicons  $\widehat{Z}(\tau_N)$ , *true* “interaction” can be conducted only via elementary material agents, singularities of the  $\mathbb{B}$  field, or, equivalently, *caustics* of the complex null rays’ congruence. Apart of the focal line itself, these are defined by the condition of *multiplicity of roots* of CNC equation (3.1) which reads:

$$D' := \frac{dD}{d\tau} = 0. \quad (3.4)$$

For an arbitrarily taken “observation point”  $Z$ , set of solutions of the joint system of equations (3.1) and (3.4) is, generically, empty. Instead, one has to deal with a “world line of an *elementary* (point-like) observer”  $Z_O(\lambda)$ ,  $\lambda \in \mathbb{C}$  (see for details [1, 3]). Then equations

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<sup>2</sup>However, this equation differs from the usual one in the random complex nature of the evolution parameter  $\tau$ .

(3.1), (3.4) (with corresponding exchange  $Z \leftrightarrow Z_O(\lambda)$ ), generically, define a discrete set of mutually related values of evolution parameters  $\{\lambda_N, \tau_N\}$  indicating the “instants”  $\lambda_N$  at which a reception of a caustic-signal at the observation point occurs (with  $\tau_N$  being then the analogue of the “retarded time”). This, however, corresponds to the situation when *some two of duplicons merge* at the point  $\widehat{Z}(\tau_N)$ ; this corresponds to a multiple root of the CNC equation. It is an easy exercise to demonstrate that the arising caustic-signal represents itself a null straight line connecting  $Z_O(\lambda_N)$  and  $\widehat{Z}(\tau_N)$  (in the underlying complex  $\mathbb{B}$  space) or, respectively, a rectilinear light ray propagating towards an observation point  $X_O$  from corresponding point of location of two instantaneously merging duplicons  $\widehat{X}$  (in the induced real space-time  $\mathbf{M}$ ). Note that any caustic line (ray) is a locus of *branching points* of (generally multi-valued) fundamental  $\mathbb{B}$  field (as well as of associated 2-spinor and twistor fields), whereas associated gauge and curvature fields undergo infinite amplification (that is, are singular), see, e.g., [5] and references therein.

Thus, in the presented formalism any duplicon is in a sense permanently “invisible” for a given “observer” unless at a discrete set of instants when a light-like signal, a “quantum”, arrives from the point of its merging with another duplicon. It is thus impossible to regard a single duplicon as a pre-image of an elementary particle, as a truly material object. Instead, one is forced to accept the concept of “dimerous electron” [3].

Specifically, one concludes that an “electron” not only “consists” of two identical point-like parts – duplicons – but does not even *exist* during the whole time interval between some two subsequent merging acts. Such a conjecture on the *dimerous* nature of electron could seem rather strange and insufficiently grounded from the physical viewpoint but is supported by a number of recent experimental observations, in particular, on *fractal charges*. On the other hand, rigid mathematical structure of the biquaternionic algebrodynamics unavoidably points just to such an “exotic” picture of the World. For a more detailed discussion of the conjecture we again refer the reader to [3].

#### 4 Invariant geometrical phase and quantum interference

It has been already mentioned in Sec.1 that the primary complex geometry of  $\mathbb{B}$  space with  $\mathbb{C}$  valued invariant not only induces an effective Minkowski-like real geometry (via its modulus part). It also gives rise to an *invariant phase* leading thus to the geometry of physical space-time with an additional  $U(1)$  fiber-like structure. This property is completely preserved under the generalization of geometry presented in Sec.2.

Specifically, the principal complex invariant (2.2) of the  $SO(3, \mathbb{C})$  automorphisms of  $\mathbb{B}$  (and of the  $SL(2, \mathbb{C})$  left (right) shifts of elements  $Z \in \mathbb{B}$ ) can be represented in an ordinary exponential form:

$$\Sigma = \det Z = S e^{i\alpha} \quad (4.1)$$

where  $S = |\Sigma|$  is the real non-negative Minkowski-like interval (2.3) expressible through the effective coordinates (2.5),

$$S = \sqrt{T^2 - \mathbf{R}^2} \geq 0, \quad (4.2)$$

and  $\alpha \in \mathbb{R}$  is the above presented phase invariant of the  $\mathbb{B}$ -symmetry transformations. Together with  $S$ , it forms the principal *evolution parameter* (“complex proper time”) but the

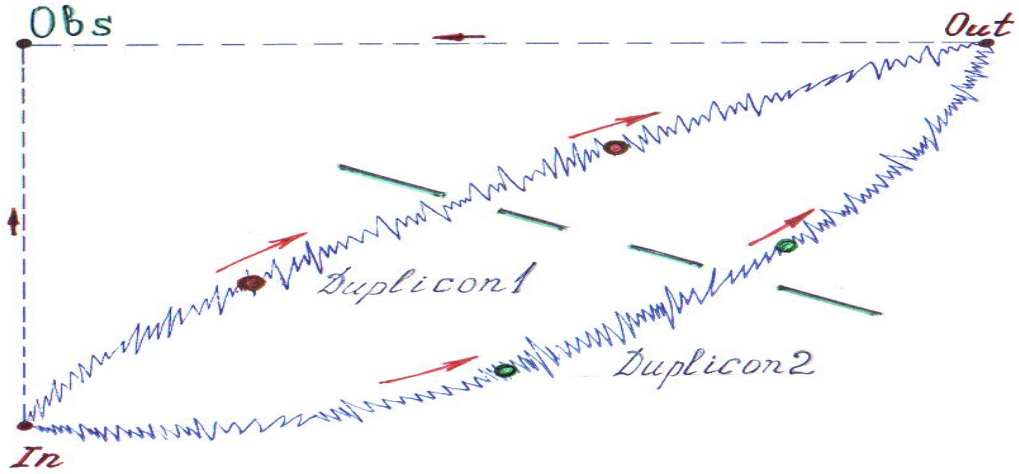


Рис. 1: Mergings of duplicons in a two-slit experiment

order of successive events is indefinite and should be assumed additionally, through fixing a particular form of the “evolution curve”  $\alpha = \alpha(S)$  [1].

We are now in a position to transparently explain the phenomenon of quantum interference without any appeal to the wave-particle dualism [3]. Indeed, suppose that two duplicons merge together radiating a signal towards an observer “Obs” (“preparation” of an initial state “In”, Fig.1). After this, the two duplicons diverge in space and, in particular, can pass through different slots of a diffraction grating (a crystal). However, the final signal (from an “electron arrived at a screen”) one can get when only the two duplicons merge again at a particular point of the *complex* space (“Out” state, Fig.1). Since at the initial and final points of merging *complex coordinates* should be fixed, the phase lags along the world lines of duplicons 1 and 2 can differ only by  $\Delta\alpha = 2\pi N$ ,  $N \in \mathbb{Z}$ .

In the simplest case one assumes that *the increment of the geometrical phase along any trajectory is proportional to the corresponding increment of the proper time*,

$$\delta\alpha = \frac{2Mc^2}{\hbar}\delta S, \quad (4.3)$$

$M$  being the electron rest mass (which acquires here the sense of a universal physical constant). We direct the readers’ attention that this relationship is, in fact, of universal and fundamental nature. In the forthcoming papers we are going to demonstrate this, in particular, on the base of the ideas of I.A. Urusovskii and the 6D geometry of extended space-time he proposed (see, e.g., [9] and references therein).

Note also that the proportionality factor is taken to be equal to the doubled *de Broglie frequency* of an hypothetical “internal gyration” of a microparticle. Here, however, none oscillation actually takes place <sup>3</sup>, and the phase lag is completely of algebro-geometrical nature. We notice also that, in the scheme in question, precisely this numerical value of

<sup>3</sup>Just such a doubled value of internal frequency naturally arises in a number of alternative approaches, in particular, in different models of classical spinning particles [10, 11]

effective frequency has been choosed in order to establish correspondence with the non-relativistic limit, see below.

Consequently, the (discrete) points of possible detection of electrons at the screen exactly correspond in position to the condition of maxima of the classical interference, namely

$$\Delta\alpha = (2Mc^2/\hbar)\Delta \int \delta S = 2\pi N, \quad (4.4)$$

where  $\Delta$  in the r.h.p. means difference of the lengths of the duplicons' world lines connecting the points of some two subsequent mergings. This is mathematically equivalent to the condition for total change of the (non-integrable even after the averaging procedure) proper time  $\Delta S$  along a corresponding closed loop  $1 - 2 - 1$ , so that one obtains the following fundamental *condition of relativistic quantum interference*:

$$\frac{Mc^2}{h} \oint \delta S = \frac{N}{2}, \quad (4.5)$$

which in a sense explains the mystery of closed time loops arising in the framework of different attempts of classical interpretations of quantum interference phenomena (see, e.g., [12]).

In the non-relativistic approximation with respect to the (averaged) velocity of duplicons' motion  $V := |\delta\mathbf{R}/\delta T| \ll 1$ , one has

$$\delta S = \sqrt{\delta T^2 - \delta\mathbf{R}^2} = \delta T \sqrt{1 - \frac{V^2}{c^2}} \approx \delta T \left(1 - \frac{V^2}{2c^2}\right) = \delta T - \frac{V}{2c^2} \delta L, \quad (4.6)$$

where  $\delta L := V\delta T$  is the increment of the (averaged) path length of a duplicon in the 3D real physical Euclidean space. Taking in account that the increment of an averaged time interval  $\delta T$  itself may be effectively considered as a full diferential (see the end of Sec.2), in the first order approximation in  $V/c \ll 1$  condition of "quantum interference" aquires the form [3]

$$\oint \frac{\delta L}{\Lambda} = N, \quad \Lambda := \frac{h}{MV}, \quad (4.7)$$

so that one concludes in the non-relativistic approximation:

*A pair of duplicons may undergo two subsequent mergings (when only they radiate light-like signals and can thus be detected and identified as a whole "electron") at the points for which the (averaged, or smoothed) length of the closed loop formed by their 3D trajectories is integer in fractions of the de Broglie wavelength of electron  $\Lambda$ .*

Note that in the *free case* the above exposed procedure seems to be very close to the Feynman's representation for the wavefunction of a self-interfering micro-particle. However, here we do not appeal to the concept of the probability amplitude and even do not assume any wave-like properties of the matter dealing instead with the notion of the phase of a purely geometrical nature. A simple interference expirement to distinguish between the predictions of quantum probabilistic theory and the algebrodynamical scheme can be suggested.

Specifically, only in an *idealized situation* there exists a discrete set of points (at a screen) where the electrons (represented by merging duplicons) could be detected. In account of



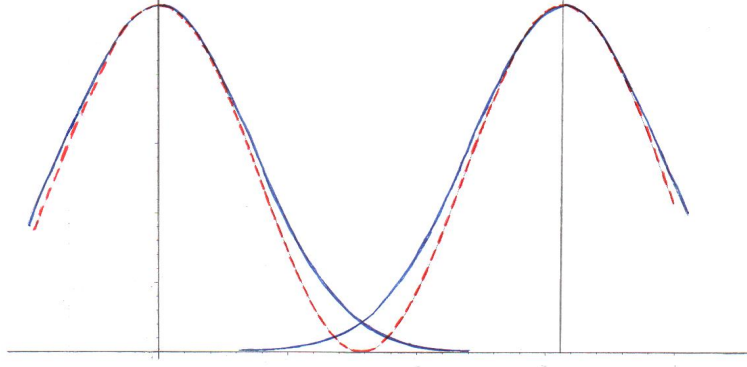


Рис. 2: Distribution of probabilities in the two-slit experiment, according to algebrodynamics (solid line) and quantum theory (dotted lines).

*statistical errors*, however, one would observe a *Gauss-like* distribution of probabilities

$$w \sim \exp \left\{ -\frac{(x - x_N)^2}{l^2} \right\} \quad (4.8)$$

in the vicinity of any of such points (with coordinates of the center  $x_N$  and dispersion  $l$ ), see Fig.2, solid lines. At the same time, quantum theory predicts the interference pattern with maxima coinciding with  $x_0$  and distribution of probabilities determined by the wave-like propagation of amplitudes and represented by the function

$$w \sim \cos^2 \left\{ \frac{x - x_N}{\Lambda} \right\} \quad (4.9)$$

(in the non-relativistic approximation), see Fig.2, dotted line. If the dispersion value is about that of the de Broglie wavelength,  $l \sim \Lambda$  (what is just a necessary condition for diffraction phenomenon to be observed), the predicted distributions coincide near maxima (up to the second derivatives) and are very close globally (Fig.2). Special consideration is thus necessary to distinguish the predicted distributions in the course of a standard electron diffraction experiment; its details will be discussed elsewhere.

## 5 Conclusion

In the article we reproduce the main results of  $\mathbb{B}$  algebrodynamics on the base of the proposed general correspondence between the primordial complex geometry and (phase extension of) real physical space-time geometry (Sec.2). It was shown that the formerly introduced concept of an ensemble of identical point-like objects, duplicons, does not seem to explicitly represent the real matter pre-elements, say, electrons (in the spirit of the famous “one-electron Universe” of Wheeler-Feynman). The true correspondence turns out to be much more refined and manifests itself at the instants of merging of some two of the duplicons, when a light-like signal is radiated towards an observation point and the “electron” can only be detected.

Such interpretation allows for transparent and successive explanation of the standard two-slit experiment, without invoking any quantum mechanical formalism and the

probability amplitude paradigm in particular, though in some aspects it resembles the Feynman path-integral treatment. Moreover, the obtained relativistic condition for the location of “interference maxima” (4.5) is a direct generalization of the familiar de Broglie non-relativistic relation (4.7) and *must be taken in account even in the framework of the orthodox quantum theory*. Indeed, formula (4.5) seems to be an explicit relativistic generalization of the *Bohr-Zommerfeld quantization condition* for periodic motion and here, moreover, it follows just from first principles. As for successive algebrodynamical approach, it only slightly differs in predictions of the probability distribution from those of the quantum theory; nonetheless, the difference could be experimentally revealed.

We conceive, of course, that the classical-geometrical explanation of a single quantum phenomenon is insufficient for seriously taking the approach as a consistent alternative to the accepted quantum paradigm. However, the above presented treatment visually demonstrates that the mysterious quantum phenomena might receive quite unexpected and even striking explanation on the base of pure geometry. We hope, moreover, that other phenomena including “quantum non-locality” will also find a clear classical interpretation in this framework.

## References

- [1] V.V. Kassandrov, in: *Proc. Int. Conf. on Physical Interpretations of Relativity Theory*, eds. M.C. Duffy et al. – Bauman Tech. Univ. Press, Moscow-Liverpool-Sunderland, 2005, p. 45; [www.arxiv.org](http://www.arxiv.org), gr-qc/0602064.
- [2] V.V. Kassandrov // *Gravit. & Cosmol.*, **11**, 354 (2005); [www.arxiv.org](http://www.arxiv.org), gr-qc/0602088.
- [3] V.V. Kassandrov // *Phys. Atom. Nuclei*, **18**, 813 (2009); [www.arxiv.org](http://www.arxiv.org), 0907.5425.
- [4] V.V. Kassandrov, *Algebraic Structure of Space-Time and Algebrodynamics*. – Peopl. Fien. Univ. Press, Moscow, 1992 (in Russian); see also  
V.V. Kassandrov // *Gravit. & Cosmol.*, **3**, 216 (1995); [www.arxiv.org](http://www.arxiv.org), gr-qc/0007027.
- [5] V.V. Kassandrov, in: *Space-Time Structure: Algebra and Geometry*, eds. D.G. Pavlov et al. – Lilia Print, Moscow, 2007, p. 441; [www.arxiv.org](http://www.arxiv.org), 0710.2895.
- [6] F.I. Feudorov, *The Lorentz Group*. – Nauka, Moscow, 1979 (in Russian).
- [7] Lind R.W., Newman E.T. // *J. Math. Phys.*, **15**, 1103 (1974).
- [8] R.P. Feynman, *Nobel Lecture*. // *Phys. Today*, **19**, 13 (1966);  
R.P. Feynman // *Rev. Mod. Phys.*, **17**, 157 (1945); **20**, 367 (1948).
- [9] I.A. Urusovskii // *Phys. Wave Phenom.*, **18**, 185 (2010).
- [10] M. Rivas, *Kinematical Theory of Spinning Particles*, Dordrecht: Kluwer (2001);  
M. Rivas // *J. Phys. A: Math. Gen.*, **36**, 4703 (2003).
- [11] V. Kassandrov, N. Markova, G. Schaefer, A. Wipf // *J.Phys. A: Math. Theor.*, **42**, 315204 (2009); [www.arxiv.org](http://www.arxiv.org), 0902.3688.

- [12] M.J. Rave, // *E-print*, [www.arxiv.org](http://www.arxiv.org), 0806.3970;  
C. Anastopoulos, N. Savvidou // *Int. J. Theor. Phys.*, **41**, 529 (2002); [www.arxiv.org](http://www.arxiv.org),  
quant-ph/0007093.